

§ 23.627 Fatigue strength.

The structure must be designed, as far as practicable, to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal service.

§ 23.629 Flutter.

(a) It must be shown by the methods of paragraph (b) and either paragraph (c) or (d) of this section, that the airplane is free from flutter, control reversal, and divergence for any condition of operation within the limit V-n envelope and at all speeds up to the speed specified for the selected method. In addition—

(1) Adequate tolerances must be established for quantities which affect flutter, including speed, damping, mass balance, and control system stiffness; and

(2) The natural frequencies of main structural components must be determined by vibration tests or other approved methods.

(b) Flight flutter tests must be made to show that the airplane is free from flutter, control reversal and divergence and to show that—

(1) Proper and adequate attempts to induce flutter have been made within the speed range up to V_D/M_D , or V_{DF}/M_{DF} for jets;

(2) The vibratory response of the structure during the test indicates freedom from flutter;

(3) A proper margin of damping exists at V_D/M_D , or V_{DF}/M_{DF} for jets; and

(4) As V_D/M_D (or V_{DF}/M_{DF} for jets) is approached, there is no large or rapid reduction in damping.

(c) Any rational analysis used to predict freedom from flutter, control reversal and divergence must cover all speeds up to $1.2 V_D/1.2 M_D$, limited to Mach 1.0 for subsonic airplanes.

(d) Compliance with the rigidity and mass balance criteria (pages 4-12), in Airframe and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" (published by the Federal Aviation Administration) may be accomplished to show that the airplane is free from flutter, control reversal, or divergence if—

(1) V_D/M_D for the airplane is less than 260 knots (EAS) and less than Mach 0.5,

(2) The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited in use to airplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span, and

(3) The airplane—

(i) Does not have a T-tail or other unconventional tail configurations;

(ii) Does not have unusual mass distributions or other unconventional design features that affect the applicability of the criteria, and

(iii) Has fixed-fin and fixed-stabilizer surfaces.

(e) For turbopropeller-powered airplanes, the dynamic evaluation must include—

(1) Whirl mode degree of freedom which takes into account the stability of the plane of rotation of the propeller and significant elastic, inertial, and aerodynamic forces, and

(2) Propeller, engine, engine mount, and airplane structure stiffness and damping variations appropriate to the particular configuration.

(f) Freedom from flutter, control reversal, and divergence up to V_D/M_D must be shown as follows:

(1) For airplanes that meet the criteria of paragraphs (d)(1) through (d)(3) of this section, after the failure, malfunction, or disconnection of any single element in any tab control system.

(2) For airplanes other than those described in paragraph (f)(1) of this section, after the failure, malfunction, or disconnection of any single element in the primary flight control system, any tab control system, or any flutter damper.

(g) For airplanes showing compliance with the fail-safe criteria of §§ 23.571 and 23.572, the airplane must be shown by analysis to be free from flutter up to V_D/M_D after fatigue failure, or obvious partial failure, of a principal structural element.

(h) For airplanes showing compliance with the damage tolerance criteria of § 23.573, the airplane must be shown by analysis to be free from flutter up to V_D/M_D with the extent of damage for which residual strength is demonstrated.